Faculty of Manufacturing Engineering

DEVELOP MATHEMATICAL MODEL FOR BIOMECHANICAL FACTORS FOR PROTON SAGA DRIVER SEAT

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DECLARATION

I declare that this thesis entitled “Develop Mathematical Model for Biomechanical Factors for Proton Saga Driver Seat” is the result of my own research except as cited in reference. The thesis has not accepted for any degree and is not concurrently submitted in candidate of any other degree.

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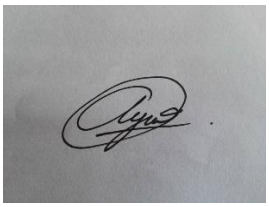
APPROVAL

I hereby declare that I have read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the award of Master of Manufacturing Engineering (Industrial Engineering).

Signature : 

Supervisor Name: Prof Madya Dr Seri Rahayu Kamat

DEDICATION

For my beloved parents:

Mr. Mohd Yusoff Bin M.K. Mohd Mydin

Mrs. Najiya Binti Anwar Ali

To my beautiful sisters:

Nurhanna Binti Mohd Yusoff

Nur Farhana Binti Mohd Yusoff

To my supportive Supervisors and friends:

PM Dr. Seri Rahayu Kamat

Dr. Syamimi Binti Shamsuddin

Ms. Sharifah Nadya Binti Syed Azmi

Mohammad Firdaus Ani

Siti Najihah Binti Zainal Rashid

Nur Alya Syaherah Binti Mohd Hassan

ABSTRACT

Automotive industry is the main industrial that leading in Malaysia development towards achieving Industrial Revolution 4.0. Safety will be their very first priority while manufacturing a car. During manufacturing process, external and internal components should be comply with the standard that have been set up by the authority. The most important components for the driver will be their seat. Upon driving for a long journey, drivers tend to feel weak and fatigue as time pass by. As a result, this could lead to accidents. Therefore, aim of the study is to develop mathematical modeling based on the psychophysical and biomechanical factors that contribute to the driver fatigue of Proton Saga. The discomfort area will be investigate through online survey and validate using Minitab software. Meanwhile, as for the relationship of the psychophysical and biomechanical will be analyze by simulator and real road conditions also determine the hardness of the seat foam. Based on obtain parameters, the regression analysis will develop and validate the mathematical model for Proton Saga driver seat as the benefits of mathematical modelling able to simplify complex situations and helps our understanding the real world as certain variables can readily be changed.

MEMBINA MODEL MATEMATIK UNTUK FAKTOR BIOMEKANIKAL UNTUK KERETA PEMANDU PROTON SAGA

ABSTRAK

Industri automotif adalah industri utama yang memimpin pembangunan Malaysia ke arah mencapai Revolusi Industri 4.0. Keselamatan akan menjadi keutamaan pertama mereka semasa membuat kereta. Semasa proses pembuatan, komponen luaran dan dalaman harus mematuhi standard yang telah ditetapkan oleh pihak berkuasa. Komponen yang paling penting bagi pemandu adalah tempat duduknya. Setelah memandu untuk perjalanan jauh, pemandu cenderung merasa lemah dan keletihan seiring berjalannya waktu. Akibatnya, ini boleh menyebabkan kemalangan. Oleh itu, tujuan kajian adalah untuk mengembangkan pemodelan matematik berdasarkan faktor psikofizik dan biomekanik yang menyumbang kepada keletihan pemandu Proton Saga. Kawasan ketidakselesaan akan disiasat melalui tinjauan dalam talian dan mengesahkan menggunakan perisian Minitab. Sementara itu, untuk hubungan psikofizik dan biomekanik akan dianalisis oleh simulator dan keadaan jalan sebenar juga menentukan kekerasan busa tempat duduk. Berdasarkan parameter perolehan, analisis regresi akan mengembangkan dan mengesahkan model matematik untuk tempat duduk pemandu Proton Saga kerana faedah pemodelan matematik dapat mempermudah situasi yang kompleks dan membantu kita memahami dunia nyata kerana pemboleh ubah tertentu dapat dengan mudah diubah.

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LIST OF ABBREVIATIONS

PROTON	-	Perusahaan Otomobil Nasional Berhad
SUV	-	Sport Utility Vehicle
ANOVA	-	Analysis of Variance
EMG	-	Electromyography
ESC	-	Electronic Stability Control
LDW	-	Lane Departure Warning
IRF	-	Injury Risk Factor
ATP	-	Adenosine triphosphate
BMI	-	Body Mass Index
RSM	-	Response Surface Methodology

CHAPTER 1

INTRODUCTION

Chapter one introduces the background of study which will investigate to posture problems occurs in an automotive industry. On top of that, this chapter also comprises 5 sub-title which are the research background, problem statement, research objectives, research scope and significant of research.

1.1 Background of study

In this modern civilization, having a transportation is a must in order to travel from one place to another. Majority of the people own minimum a car in one house. As a Malaysian, automotive industry have been established in Malaysian since 7 May 1983 by the name of Perusahaan Otomobil Nasional Berhad (PROTON). There are few models manufacture by the company which are Proton Ertiga, Saga, Pesona, Perdana, Iriz, Suprima S, Preve and Exora. Currently, PROTON introduced its vey first Sport Utility Vehicle (SUV) model known as PROTON X70 collaborating with new partner Zhejiang Geely Holding Group.

Given all the layout, while manufacturing the cars safety has become their main concern. When it comes to safety it will be completely linked with its driver, passenger and people out there. Most of the citizen travel daily as to purchase daily groceries or doing outdoor activities by Swedish travel survey investigate by (Olsson, 2011). People tend to get tired and fatigue while driving for a long time. A research done by (Sammonds, Fray and Mansfield, 2017) prove that drivers feel fatigue or discomfort from 80 minutes to 110 minutes of driving. This linked to the psychophysical and biomechanical whereby effect to the posture and emotional state of the drivers.

Psychophysical related to the mental and emotional state of a person. There are several methods for investigating psychological factors such as anthropometric data collection,

electromyography (EMG) or user studies and observations. EMG may be used to assess muscle reaction to muscle simulation that helps identify neuromuscular irregularities by a nerve. For instance the person's tired and comfort level. Next, Biomechanical Factors can be described as the size, structure and mass properties of body parts, joints linking the body, muscles generating body movements, joint mobility, body mechanical reactions forcing fields and voluntary body movements when applying forces to external objects (Bhise & Vivek D., 2012). There were research done by (Bowden and Ragsdale, 2018) developed a mathematical model for truck drivers based on the fatigue with level of alertness.

Every seat in a car was built according to regulations. The distinction would be the scientific information that supports the design of a supportive car seat, and the impact of new technologies such as relaxation systems, neck rest, ultra-light seats, lumbar supports and seat shape is uncertain (M.Manfred, 2010). Some of the buyer might considered this factors during purchasing a car (Zenk & Raphael, 2008). Each driver have their own style or posture of seating whether seat comfortably , seat more to the right side or left side. This posture will lead to a pressure distribution reading. Seat pressure distribution known as the interface between human body and surface of the seat. There is, for example, a person sitting on the car seat and feeling squeezed under the lower body, such as hip. Because of the psychophysical and biomechanical factors, if the person feels discomfort as easy to feel pain at the boy's lower part and tired during their driving either close or long journey, it will affect the driver fatigue and tend to involve in accidents.

Therefore, this research propose a mathematical modelling based on the biomechanical factors Proton Saga driver seat.

1.2 Problem Statement

This project is a collaboration together with PROTON Berhad specifically in Research and Development department (R&D). The main purpose of this project is to have a standard mathematical model to be used by Proton Saga model focusing for driver seat. After brainstorming together with Ergonomic Leader, a discussion have been made based on the customers complaint and standard requirements, that mathematical model developed as a guideline while designing the driver seat.

Zero number of accidents cannot be achieved however, as a person, they can reduce the number of accidents if it includes cars, bikes or even buses and lorries. Studies show that traffic accidents and road fatalities are on the rise from 2008 to 2017 (MIROS, 2018). Table 1.1 shows the statistic of road accidents in Malaysia from 2008 to 2017.

Table 1.1: Statistic by MIROS (MIROS, 2018)

NEGERI *State*	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
PERLIS	1,417	1,633	1,548	1,791	1,881	1,895	1,888	1,861	2,062	1,925
KEDAH	16,520	17,701	17,966	19,699	19,935	20,228	20,159	22,016	23,200	23,262
PULAU PINANG	34,049	33,719	34,306	37,158	37,851	39,361	38,747	39,856	42,244	43,007
PERAK	30,539	32,327	32,072	33,506	34,714	35,408	35,131	36,736	38,531	38,587
SELANGOR	100,380	107,429	115,565	128,876	129,106	135,024	137,809	140,957	151,253	154,958
W.P. KUALA LUMPUR	48,671	51,942	53,493	58,795	61,872	64,527	63,535	64,664	68,866	72,940
NEGERI SEMBILAN	17,362	18,369	19,407	21,157	22,146	23,066	23,748	22,939	24,428	24,941
MELAKA	12,105	13,275	14,110	14,720	15,195	16,083	16,375	17,069	18,601	18,771
JOHOR	48,667	51,747	55,381	59,501	62,316	64,600	64,473	67,112	73,116	76,121
PAHANG	15,629	17,068	17,315	19,001	20,554	20,130	19,071	19,635	20,465	20,813
KELANTAN	8,842	9,549	9,707	9,603	9,968	9,748	10,326	9,960	10,544	10,786
TERENGGANU	8,814	10,118	10,106	10,684	10,861	10,996	9,383	10,381	10,793	10,713
SABAH	14,588	15,798	16,192	16,585	17,446	17,438	17,858	17,290	17,298	17,244
SARAWAK	15,488	16,655	17,253	17,964	18,578	18,700	17,693	19,130	20,065	19,807
JUMLAH *Total*	373,071	397,330	414,421	449,040	462,423	477,204	476,196	489,606	521,466	533,875

Meanwhile, a latest statistic developed by (Rohayu S, 2012) shows that based on the ARIMA model produced, the number of deaths is expected to increase to 8,760 (2015 year) and 10,716 (2020 year) respectively as illustrated in Figure 1.1 below.

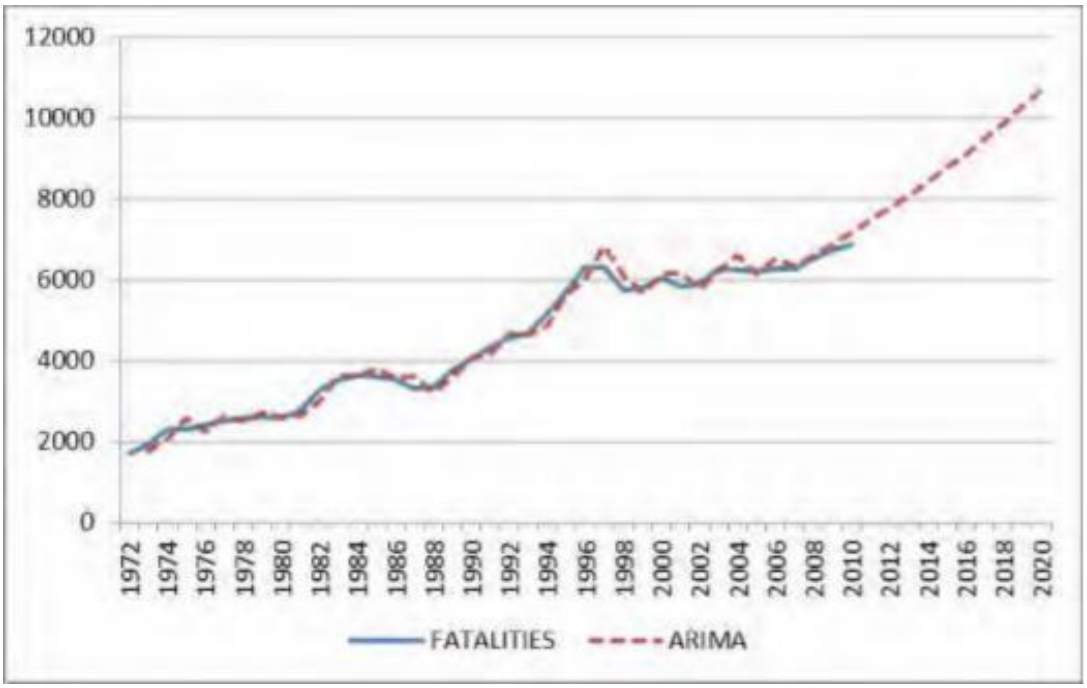

Figure 1.1: Statistic by MIROS (Rohayu S, 2012)

From the above statistics, there are several causes of accidents that might occur during driving, such as feeling uncomfortable or back pain for a long journey, being tired, sleepy or reckless or ignoring traffic rules. According to World Health Organization, Malaysia has been ranked as one of the top three countries in the world deadliest roads (Ruxyn, 2017). On the other hand, there have been studies demonstrating a major relationship between emotion, personality characteristics, role modeling and the attitude of the driver towards safety (YII & Julia Lau Siew, 2015).

A pilot research was conducted in this research which distributed a survey for 40 respondents in order to measure the level of comfort. Figure 1.2 shows the data prove that the comfort factors while driving is poor body posture.